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ABSTRACT

A method for the assessment of competence in language is suggested that allows a new approach to the study of the sources and conditions of competence development. The method builds on the functional analysis of text building behavior, making use of the discontinuities in produced text as the only reliable observations from a scientific point of view. The method is known as Perspective Text Analysis. It characterizes the mechanism that has been discovered to govern text production and to foster an understanding of the actual processes of movement in language. The functional analysis of qualitative stability in text building behavior incorporates the double aspect of time into the approach, partly through an algorithm that takes care of the dynamics in text building behavior, and partly through the sequencing in text production that secures its evolutionary aspect. Aspects of competence are presented concerning five different areas. By means of global state attractors resulting from the perspective of anticipated consequences, mental determinants are presented. On the basis of established temporal morphologies, the kinds of determinants that constrain one's thinking under various experimental conditions are shown. Five tables illustrate concepts under discussion. (Contains 35 references.) (SLD)

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Abstract

Based on typical tasks required in ability testing, a general conclusion drawn in the international research literature is that intelligence is not different from e.g. McClelland's achievement testing. To many psychologists this means that the concept of competence is insignificant and that intelligence as well as related aptitude tests are sufficient in the assessment of performance. Further, it is generally assumed that the intelligence quotient (IQ) constitutes a measure of cognitive development. Moreover, it is believed that the IQ correlates more or less perfectly with intellectual achievements. These assumptions are challenged because they are the result of obvious misconceptions. The present article is about a method for competence assessment that allows an entirely different approach to the study of the sources and conditions of competence development. The method builds on the functional analysis of text building behaviour. In this respect it makes use of the discontinuities in produced text as the only reliable observations from a scientific point of view. The method has been made known as Perspective Text Analysis (PTA). Its task is to characterise the mechanism that has been discovered to govern text production and to foster an understanding of the actual processes of movement in language. It follows that the study is on the expression of competence through a functional analysis of qualitative stability in text building behaviour. This incorporates the double aspect of time into the approach, partly by means of an algorithm that takes care of the dynamics in text building behaviour, partly through the sequencing in text production that secures its evolutionary aspect. Aspects of competence are presented concerning five different areas. By means of global state attractors resulting from the perspectivation of anticipated consequences, mental determinants are presented. On the basis of established temporal morphologies, it is shown what kind of determinants constrain one's thinking under varied experimental conditions.

Brain and Behaviour

The most fundamental distinction in psychological research has been introduced by the artificial imposition of a dividing line between studies of mental processes on one hand and the study of behaviour on the other. The underlying assumption made by almost all researchers is that human experience requires the processing of information as carried out by cognitive functions. Further, it is assumed that the processing of sensory input is functionally specific and dependent on a motor output which is the basis of behavioural feed-back loops making possible hypothesis testing and the development of interactive strategies of behaviour. The classical hypothesis states that visual pathways of the brain break a "retinal image" down into a number of abstract features which are processed by independently working cognitive functions. Under this hypothesis it is assumed that these features are stored in what is called memory. It follows that the studies of mental processes concern the limitations in capacity of the cognitive functions involved in the creation, abstraction, and manipulation of abstractions in order to generate appropriate behaviour.

The main question raised in the study of intelligent behaviour is whether and to what extent the concept of memory can be used as a suitable **construct** that can explain cognitive processes without requiring a further reduction. Constructs are believed to constitute the basis of the execution of complex patterns of behaviour. They are established by testing the following kind of expression: ($Y = f(X)$). The expression says that X is the score on a test that is assumed to measure the construct and Y is the performance score. The usually made inference is that an experimental subject doing well on test X will perform well on the activity Y. The zero hypothesis corresponding to this model would imply that no relationship between test performance and activity performance can be established.

But test scores per se do not attract attention in the discussion of a particular construct. What concerns the researcher the most is the establishment of its biological roots and the extent to which inferences about its biological validity can be justified. The biological roots of one of the most discussed and debated constructs in psychology, namely intelligence, has been of great concern to Jean Piaget's (1952) most characteristic research: "The origins of intelligence in children".

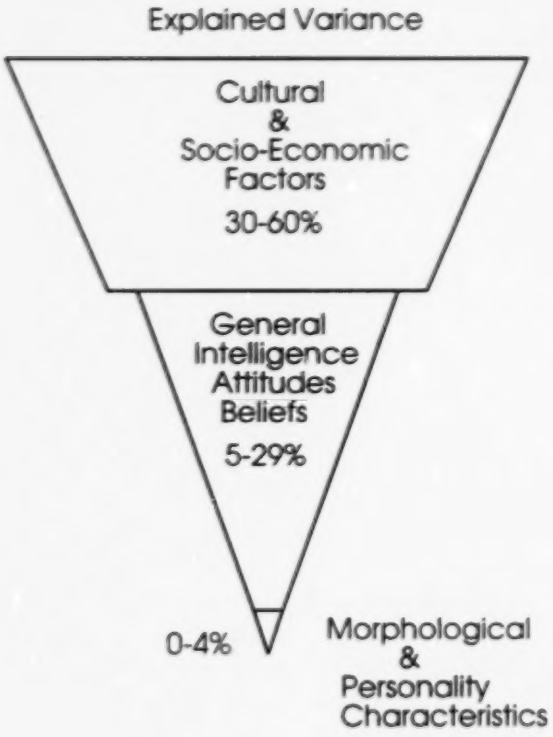
The Behavioural Foundation of Intelligence

Basic to Piaget's behavioural study of intelligence are such activities as (1) exploration, (2) manipulation, and (3) play. A model that gives formal expression to the observation that an experimental subject **can** recursively carry out a certain action which by chance has led to an advantageous **movement** in accidental response to a particular event is the following: ($E_1a_1a_2E_2$). The model as discussed in Bierschenk (1994) builds on the assumption that visual exploration and the acquisition of skills successively become internalised. The urge to find out about the environment and to control the effect of one's actions upon it is conceived of as the strongest evidence for a motivation to attain **competence**. It follows that Piaget's model identifies "competence" with knowledge and knowledge with success of mastering important features of the environment. As Piaget (1978) argues, intelligent behaviour cannot be based on retrieval of information from memory. Instead it has to be based on transcendence. The result of this need of diversification is the necessity of a transcendent solution as opposed to a copy retrieved from memory. Therefore, mental processing may be understood with respect to its positivistic form (i. e. form of symbolism) on one hand and its variability (i. e. degree of abstractness) on the other. This frame of a genetic epistemology has been integrated into the study of behavioural genetics (Hakstian & Vandenberg, 1979; Royce & Mos, 1979). These researchers have taken over the traditional framing of the study of competence according to the following two hypotheses. The first one assumes that behaviour is teleonomic in nature and aimed to transform the environment as well as to preserve experience and to increase the

organism's capacity to structure this environment. Therefore processes of genetic reproduction become the key to the explanation of intelligent behaviour. The alternative hypothesis proposes a cultural or environmental factor to be responsible for the major part of variation in competence development (Sue & Okazaki, 1990). Thiessen (1979) suggests that "assortative mating" is responsible for maximising the variation in the "gene pool" of a population. Accordingly, one might expect a filter effect working from the endowment of intelligence toward cultural and socio-economic layers. Based on Vandenberg's (1972) study the following filtering process shown in Figure 1 has been discovered during courtship in assortative mating of humans.

Figure 1.

Vandenberg's Assortative Mating Filter



The highest degree of assortative mating appears when certain similarities and differences in genetic, physiological and behavioural aspects pass through a "frame of reference" of specified expansion. Technically this expansion has been calculated by means of the product-moment-correlation (r) which have been converted into proportions of common variance (r^2). The culture hypothesis gets support in Vandenberg's observation that socio-economic and cultural factors account for the major part of the variance explained. This suggests that cultural values and family practices affect competence development and upward mobility more than anything else. Moreover, it seems to support the common conviction that occupational success is highly dependent on similarities in socio-economic factors.

After passing through this frame of reference, another filter effect can be observed. Selection is based on a much more restricted range, because now it is made on the basis of a general intelligence factor as well as on attitudes and beliefs. For example it is believed that schools and comparative social institutions have impact on the development of competence.

Further it is believed that they contribute to systematic differences in occupational achievement (Barret & Depinet, 1991). But screening at this level accounts for only a small part of common variance between mates.

When selection is made with an eye on highly specific morphological and personality characteristics of the mate, such as weight, neurotic tendencies and other specific aspects the common variance proportions are negligible. In behavioural genetics this has been interpreted as an indication of a mechanism that maximises the number of common genes in the offspring generation. The mechanism is conceived of as a preventer of directional selection. This may be taken as a partial explanation why the nomological network has been unable to demonstrate the predictive value of intelligence.

Moreover, the construct of intelligence seems to be useless in the prediction of one's success on problem solving tasks (Dörner & Kreuzig, 1983; Dörner, 1984). Problem solving in its simplified or purified form has been approached by means of computer simulation (Newell & Simon, 1972). They showed that certain classes of puzzle solving situations could be attacked with techniques of relevance for solutions of academic problems such as mathematics. These have a fixed space, which means that learning as a precondition is excluded. Informal observations of recent simulations of multiple problem solving tasks indicate that peak performances do not predict the existence of an acceptable and criterion oriented problem solving strategy. As an answer to this kind of "error variance", Anderson's (1993) ACT model is often cited as an example of a procedure that can achieve the acquisition of problem solving skills. Performance of the model builds on production rules which are defined over event-action-pairs. The description of the event is a statement of the conditions under which the action has to be performed. Thus the degree of abstractness of the action operator marks the range of problems to which Anderson's model can be applied. Even with the incorporation of aspects from learning theory, problem solving is still far removed from the prediction of performance on real tasks.

The methods developed thus far do not provide any feasible mechanism by which academic or occupational performance can be predicted despite the fact that considerable efforts have been invested in the development of methods for their prediction. Entire institutions, as for example Educational Testing Service, have been set up for the standardisation and validation of "mental test scores" (Lord & Novick, 1968). This kind of activity includes all types of mental abilities and scholastic aptitudes. Despite enormous investments that have been made over the years, no successful definition of the concept of competence has been achieved nor has it been possible to demonstrate what "these scores really mean" (Helms, 1992).

Against this background it may not come as a surprise that McClelland (1973) argued that aptitude test in general and intelligence tests in particular can predict neither occupational success nor other important life outcomes. In addition, he questioned the value of grades earned in school as valid predictors of occupational success in later life. Because correlational results are used to accept or reject an articulated hypothesis on the basis of tests of significance, this assertion makes sense if the statement is coupled with the observation that academic performance predict job performance successfully only to the degree that there exists an underlying relationship with social status.

McClelland takes the credit of having observed that psychologists have been unable to make a clear cut distinction between intelligence and competence. It was his paper on "Testing for Competence rather than for 'Intelligence' that directed public attention to the confusion of both notions. Though, despite the fact that McClelland, his co-workers and followers have managed to be widely recognised and often cited, they have not been able to initiate a change toward the assessment of competence. The notion remains to be used as "container" for disposal of all kinds of generative cognitive capabilities as well as social, and behavioural skills.

At the root of the problem one finds a continued ambiguity in its definition. Because of McClelland's broad as well as trait-based definition, the notion "competence" is still without contrast in relation to intelligence and thus without any possibility to serve its purpose of defining what is within its boundaries. Since it covers almost any aspect of Murray's (1963) "Explorations in Personality", e.g. motives, skills, aspects of one's self-image, social role, and body of knowledge, it is useless as scientific concept and basis for the establishment of a psychological construct. In general, any enduring characteristic of a person that shows regularity is taken as an expression of competence.

The situation becomes even more complicated by McClelland's content-oriented validation approach. This means that underlying aspects of a person's performance are "measured" by letting the subject describe what makes him performing successfully on the job. Confidence is placed upon self-description and the classification of statements. Moreover, the Picture Story Exercise has been defined as a content-valid assessment technique, because it supports inferences based on mental processes, i. e. thought patterns used on the job. Though on the basis of the generally accepted research paradigm content-oriented strategies have to be judged as inappropriate. From this point of view mental processes can only be validated with a construct-oriented approach. Horst (1966, p. 268) noted:

"Projective or unstructured tests should not even be regarded as appropriate psychological measuring instruments. We must recognise, of course, that great pressures are exerted by clinical and other psychologists to preserve the unstructured free-response, free-interpretation type of measuring procedures, because they feel that from such instruments they get a far better understanding of the individual than with the highly structured procedures. But evidence to date in support of this argument is poor, and the nature of the case is difficult for the claims of these persons to be objectively evaluated."

By applying this perspective to McClelland's approach to competence, it becomes obvious that a method entirely built on a content analysis of told stories cannot be considered to be scientifically acceptable. Content-oriented validation strategies are barely tolerated by the nomological network as a basis for support of inferences about mental processes and even less respected.

Unfolding Competence

Progress in becoming a person and gaining significance begins in the head of the individual subject. Therefore a method is required that makes explicit to what extent a particular subject can exert **perspective control** over his existence. Overview or perspectivation implies co-operation between a person's experience of his physical and social environment and the cognitive integration the person can achieve of ecologically significant information. In this sense growth implies the development of a firmly integrated conceptual structure. But independent of how resolutely ecological invariants have been picked up by the perceptual system, one must still be capable of expressing one's perception of actions and events symbolically, i. e. through natural language. Otherwise, the perceived cannot be made knowable for oneself or others.

The physical conditions for the study of a language specific pickup of information is the production of a **verbal flow**. The flow is always **intentionally** produced and comprises necessarily an **orientation** which means that information becomes perspectivated. During production, numerous periods and fractions within periods help differentiate and organise the embodiment of objectives and a perspective. Thus the formation and deformation characteristics of a particular text have significance for the embedding of one's conceptualisations. A functional analysis of conceptualisations implies the development of a method that can make use of the **discontinuities** in produced text. From a nomological point

of view, these are the only reliable observations that can be made on a text. The method developed, has been called Perspective Text Analysis (PTA).

PTA builds on the discovery of an algorithmically and dynamically operating mechanism. This is the AaO mechanism whose medium of operation is language. This mechanism governs the conservation of competence through the structuring of language. Because it is founded on the Kantian **Schema** axiom, it has a direct connection to Kant. Kant's influence is acknowledged in that natural language is conceived of as the product of an underlying mental reality that remains invariant throughout transformation. The AaO mechanism is the device for communication among functionally defined strings of graphemes. It may in fact be regarded as the very basis of the definition of language as a biological system. From this statement follows an immediate connection to the physiology of perception and consequently to Helmholz, who conceived the Kantian principle of conservation of energy as the embodiment of invariance underlying all natural transformations (Prigogine & Stengers, 1985). An environmentally determined theory of perception that explicitly builds on the Kantian-Helmholz postulate of invariants has been proposed by Gibson (1979).

Of particular import for an understanding of the reality postulate of PTA is its incorporation of the Gibsonian "Law of information" (Kugler & Turvey, 1987), which means that there is no reason for separating a theory of perception from a theory of action. They contrast in that the tasks of perception are to digest, abstract, and generalise, while the tasks of action are to spell out, concretise and particularise (Turvey, 1977). It follows that the study of verbal expressions has to be carried out under the assumption that text building is a process where acts evolve by successively shifting tasks of action and tasks of perception. The mechanical work involved in the production of text is seen as an expression of the true process of transformation whereby the conditions of wholeness and implicate order (Bohm, 1990) become established. These are physical and informational in nature which means that text building is not only a transmission of movement. Instead co-ordination of perception and action is essential. In coalition, both co-operate in a systematic manner toward the evolution of a mental structure. This incorporates the double aspect of time (Prigogine, 1993) into the method, partly by means of the AaO algorithm that takes care of the dynamics in text building behaviour, partly through the **sequencing** of the movements carried out during text production. The product of text building is, through self-referential stages in discourse, involved in its own **synthesis**. Self-referentiality secures the evolutionary aspect of text.

The AaO model realises a fundamentally new way of assuming the variability of its components. The AaO as a clause/sentence model is functional and encompasses the double function of time involved in "becoming" (Prigogine & Stengers, 1985; Prigogine, 1980). The "functional clause" is a variable itself of the act that constitutes the text as a whole, that is as a synthesis in the Kantian sense. Thus it is something inherent, which repeats itself but gives constancy to the text in order to make it comprehensible. The constancy function is represented by the verb which thereby forms a link between perception (AaO on the macro level) and action (AaO on the micro level). As a consequence the operationalisation of AaO into the PTA method has created theoretical unification of perception and action.

It is unquestionable that the dynamics typical of a naturally evolving text has great communicative value irrespective of what rules of grammar the discovered pattern would elicit. There is every reason to believe that "original language" is not a matter of conventions and that information emerges most significantly in "rule breaking behaviour". In contrast to common linguistic models, the AaO axiom offers a rigorous way of modelling qualitative change. It provides for the detection of the governing agent-function materialised by an "I" in discourse. The way this "I" is laid out and structured has become accessible by the integration of the Kantian with the Gibsonian perspective. Through this approach the agent's responsibility has been put into focus, without which the perceptual determinants would hardly be transformed into mental determination.

The method together with experimental results is continuously being made available to an international audience through the series Kognitionsvetenskaplig forskning (Cognitive Science Research, ISSN 0281-9869). Educational Resources Information Centre (ERIC) as well as Information Services in Psychology (PsycINFO) is reviewing the series. The method is represented in a handbook edited by Erwin Roth, entitled "Sozialwissenschaftliche Methoden" (Social Science Research Methods, 3rd edition, 1993).

Results to be presented will refer to different areas of professional life and demonstrate whether or not temporal morphologies can be established. What kind of evolutionary processes are governing competence development will be given a rigorous expression by this method. The results of the method will be presented within a topological space. By means of global state attractors, various behavioural expressions of competence will be identified and compared. These are taken as indicators of different degrees of functional stability in the development of competence.

Modelling Text Building

Development of competence is conceived to be rooted in an evolutionary process that incorporates the **Schema** as foundation of co-ordinative structuring. Its operation is made explicit in "Text Building Behaviour". However, it cannot be interpreted from textual surface, because it is not bound to lexical components. Competence emerges in the form of a concept, whose contours are built up as a result of the co-operative mechanism of syntax. From the thermodynamic point of view emphasis in modelling has to be placed on the irreversibility in the process of differentiating a perspective. To speak with Prigogine, natural systems become structured through the flow of energy and their own internal constraints. Moreover, all natural systems exhibit multiple layers of embedded networks through which the energy associated with a flow is conserved.

Modelling the conservation of a verbal flow necessarily connects description to the introduction of a physical model and a book-keeping strategy that helps mapping the conservation across macro- and micro level descriptions of the proper "flow fields". The Agent-Objective dependency in the AaO formalism stipulates that co-operation between both has to create a particular mode of resource use, namely the **pendular clocking** ("limit cycle") mode, which forms the perspective on the objectives of a particular text. A special purpose system of computer programs, called PERTEX, allows for the description of the flow-field processes at three different levels:

At the first level of description potential energy is described according to the classical power model of physics (Feekes, 1976). The description concerns the mechanics of assembling and disassembling conservation. Based on observed geometric symmetry, the distributional characteristics of text mass and related properties such as length and time are accounted for. The geometric "layout" or distribution of the A's and O's constitute the conservation of a thermodynamic field. Whenever the atomistic A's and O's interact the larger scale of analysis defines a developmental field. Each field is of a certain length, because it consists of a variable number of A's and O's. For metrical purposes the AaO's are counted as **Blocks**. What is achieved by PERTEX at this level is a mass-dependent description of the **viscous-elastic** properties that belong to the kinetics of the language system.

At the second level, an alternative description is introduced through PERTEX. Interactive violence associated with the mass-dominated interactions of level one are now removed from the processing of text. That the description is no longer **forceful** implies that intentional and orientational aspects are taken into account. It is in this latter sense that verbal flows and their interactions provide for an **informational** description of the pattern of rhythmic movement expressed through the **asymmetrical** relation between the view-, stand-, aid-, and set-points of

a text and the textual agents. Its most important property is a connection matrix as key expression and instrument for uncovering the breaking of internal constraints as well as for studying the active role the structural relations play in defining an "arrow of time" and thus a perspective. In using the theoretical construct of the kinetics of a verbal flow, observed macroscopic motion is taken to constitute the basis for identifying **trajectories** of attractor states. Put into variational perspective, these are the **local boundary** conditions that define the local minima to the potential carried by the agent-function. A matrix is automatically produced and can also be used to reproduce the binary matrix that describes the strict dependent relation between the unique points of a particular component and its unique agents. In case of a **re-distribution** of concentrated energies, the perspective represents a transformation of the direction of the process that has generated configuration of the respective objective component. This means that, in the perspective, assemblies of patterns of strings of graphemes pertaining to the objective component can be picked up and transformed. By employing the pendular clocking mode, perspective invariants can be extracted. Extracting the perspective of a text is a unique quality of PTA.

At the third level operate the **irreversible** processes according to the second law of thermodynamics. These processes are the source of order and associated with the functional grouping of graphemes or strings of graphemes. Grouping implies assembling of patterns of strings of graphemes and the making of **constraints**. In a most important sense, **text** has its origin in the **dissipative** processes. This implies that their properties describe text as a viscous and elastic medium in which a rich variety of kinetic properties lawfully generate kinematic flow fields. These in turn specify kinetic variety. Coherent text is therefore the result of rate-independent structures (Pattee, 1977, 1980, 1982) as produced by the second law. All irreversible verbal flows involve the breaking of constraints, which provides the basis for a study of how a low-dimensional description of macroscopic work cycles can be achieved despite the high dimensionality characterising the very many micro work cycles involved in text building. Their co-ordination implies that the AaO formula is instantiated at the highest level of co-ordinative freedom. At this level the formula is brought to bear on the physics that governs the co-operative activity of its constituent component. This means that co-operativity is identified with a minimal ensemble of two variables or textual elements. When this co-operation is supported by dynamic relations as well as affinity relations between the two components (A, O), boundary conditions arise and act on the variables of these components. Provided that multivariate boundary conditions have been established, **oscillations** can be produced in the process of text building. These generate the instabilities that transform potential energy from mechanical (macro-modes) to thermal (micro-modes). Whenever conservation can be described geometrically, **lawful** physical relations between kinetic and kinematic processes can be established.

Reliability and Validity

Founded on logical positivism, classical test theory makes the experimental subject the object of measurement. Inherent in the classical design of the behavioural sciences is an orientation toward the subject's ability to attend property (p) of stimulus (X) and to develop appropriate judgements. This has resulted in behavioural semantics which views the total outcome of common sense statements on pen-and paper tests as proper responses to prescribed conditions. General measurement rules have been developed that eliminate ambiguity in the classification of responses to semantic markers. This has been accomplished through development of objective procedures that additively integrate great numbers. Recent individual-environment approaches seem to stress the benefits of viewing established constructs as a set of essentially flexible interaction strategies rather than as a set of specific intelligence or personality factors. Other researchers maintain that measurement cannot be so

restrictive and have proposed that various types of observed facts are classified by means of schedules or schemes. Though the theoretical implication of these differ with different researchers and vary over time.

Consequently, within the field of logical behaviourism, it has been proposed that linguistically defined models would be a better way of projecting environmental (contextual) information onto linguistic form. Within this field of methodological development, syntactic-semantic networks have been constructed as a means for studying cognitive mapping of semantic concepts. Because of their inability to cross artificial boundaries inherent in the classical dichotomies such as the subject-object distinction, transitivity versus intransitivity or the semantic distinction between agent and experiencer, it is very unlikely that researchers of this orientation ever will be able to provide a satisfactory answer of how it is possible that text building behaviour in a perfectly reliable and valid fashion can transform an aggregate of joint graphemes into a single functional whole, i. e. an AaO unity.

The arising question is therefore, how PERTEX possibly can constitute a reliable and valid contrast. Its superiority over the classical approaches stems from the fact, that it circumvents the construction of scales, and semantic networks as well as coupling to it a distribution of intensities. Instead, PERTEX utilises language as **medium** and thus its properties of viscosity and elasticity. This implies that competence can be studied as synthesis of perception and action and this synthesis can be detected only through language.

It follows that the researcher or any other objective frame of reference no longer provides the point of departure in the establishment of natural law. Instead, it is the individual text producer as a token of the biological system under investigation that provides the unique physical context for the expression of natural law.

The Agent as Scale Factor

Writing is a process similar to growing, especially because both are related to development. In the same way as an individual develops physically and mentally as a function of **age**, the physical growth of a text can be observed as it expands over time. However, the mental functions inherent in text do not develop exponentially with expanding mass of text. The dynamics of the text comes about through movements. These movements are characterised by **directedness**. A biological system producing a writing **style** constitutes an abstraction of the individual text producer, whose textual movements are intentional. This implies that it is always the individual text producer, who is intentionally acting, even under severe strain or experimental control. He is the agent in the text production. But to what extent the agent exerts perspective control over his existence is dependent on his style of approach.

Individual styles of writing give expression to differences in strategies of approach. Similarly, picking up information and putting it into verbal expressions along a chosen **path** may be varied by being smooth or rigid and dynamic or concentrated. Consequently, development of an **operational language space** can be associated with age but the process is **cyclic** and depends to a great deal on individual variations. The rhythm in text building behaviour can be as varied as the rhythm of life itself.

Because text is life, textual agents co-ordinate the textual objectives by moving rhythmically and functionally balanced. Of course, it may happen that an agent is involved in to much "work out" and stretching, resulting in dislocation of some parts of the "language body". To be able to tell something about the **consciousness** inherited by the textual agents requires that **biological time** comes under the control of the experimenter. Thus like human existence has an extension, a history, and a functional embedding into a context, it can be said that the consciousness comes into existence by the activity that a biological system performs in writing a text into some structural **whole**. Like the human body, the language incorporates a

generation-regeneration mechanism, which means that text is not only **self-organising** but also **self-referential**.

When text is taken as an expression of competence, it is a priori assumed that its patterns of rhythmic movement convert ecological information pickup into a architectural configuration which has meaning or significance. Similar to observed individual-environmental interactions a text backs up interactions in textual material by textual integration. Insofar as the text producer is acting on a given set of principles, the resulting text may be conceived of as an expression of his competence. Thus through transformation physical body-interactions become **meta-physical** and thus **synthetic** in text production. It follows that the expression of competence through text production must observe lawful relations and that its existence promotes a mental structure whose absolute termini (limits) and lawful connections can be discovered as the result of the meta-physical activity of the brain.

From an evolutionary point of view, it must be that the realisation of a particular concept requires the existence of certain brain states. Consequently, competence is neither uniform nor universally distributed over biological systems, but causally correlated with physical brain states as was emphasised by Sperry (1983, 1993). Since the 1960's, Gallup (1970, 1976), for example has studied primates with the purpose of finding out whether and to what degree self-recognition can be established as an index of self-awareness. This capacity provides a means by which the organism **can** begin to **reason** about "self" and to **infer** a similar mental structure in other organisms. This analytical capacity is absent in gorilla (Povinelli, 1993). The process of attributing the existence of a concept of self in orang-utans, chimpanzees and humans implies its identification with a certain brain state in one-self and others. Accordingly, the existence of biological systems, having the ability of attributing attention to and making inferences about brain states in others, provides the unique physical context for the expression of consciousness.

Moreover, certain brain states support the existence of a particular mental structure. This implies that the competence of a person is something that exists for something else. This something cannot be derived analytically out of the person himself, i. e. content-wise, because intentional content is, according to Sperry, causally correlated with the physical processes of the brain. But classical theory holds that two states cannot be both identical and causally correlated, intentional content can only be inferred. Though this problem can be circumvented at a different level of description, namely the topological. Produced competence can be realised by taking into account "non-holonomic" constraints (Kugler & Turvey, 1987) in systemic deduction. This means that termini and their connections serve as point of departure for an elaboration, articulation and differentiation, and thus a precise description of the phenomenon of competence as the product of the brain's synthetic activity.

Competence and Text Production

Synthesis means the unfolding of language as system. This is the only system at the ecological level through which multivarious geometries (or non-holonomic constraints) become available as the result of synthetic activity. This is intra-systemic and its meaning emerges only through the **Kantian schema**. In Kantian terms, the schema constitutes the methodological tool for a synthetic (or axiomatic) analysis of language expressions or discourse. A related consequence of this emphasis on dissipative structures arising out of non-linear processes involved in discourse is the ecological approach to competence development.

This approach is of a most fundamental societal concern, because it stresses the reciprocal action between competence development and language. Stating that competence has never been studied in this sense may be provocative. Nevertheless this is a radically different orientation compared to the approaches based on the principles governing the psychological methods of measuring knowledge as well as the principles underlying the study of language as discussed in linguistic literature. The ecological approach contrasts sharply to the commonly

accepted analytic or cybernetic models. Essential to the approach is the assumption that the ability of developing competence in various contexts is inborn and that its main function is to preserve the organism's survival potential.

This kind of competence is not easily defined on the basis of the "universal law" approach, because it presupposes a co-ordination of sensory and motor action schemata. In the process of co-ordination the individual seems to depend on an ability to integrate experience derived from direct contact with the environment. Spontaneously emerging structures in the environment can by this co-ordinative ability be immediately (directly) perceived. Especially in those situations where the situation appears ambiguous for the individual, because of fusion of the empirical with the formal is required, competence need to be defined operationally as the formal structure of the product of inquiry. Exactly this is achieved with PTA. It always identifies something non-logical with something logical. The non-logical aspect is the core of the phenomenon processed, while the logical aspect is its topological structure seen purely formally as element of the formal system of differential topology.

Text becomes Wholeness

Text writes itself according to **limit cycles** which implies that limit cycles control the discontinuities and changes produced by flow processes. Specifying unit time, here called a period, **clock-like cyclic** and recursive algorithmic procedures establish a dynamic regime. This means that the generation and production of a flow based on co-operatively and interactively working agents give rise to a cyclic development and the emergence singularities. A complementary process initiates a phase-dependent coupling of the flow processes involved. Unfolding this coupling shows how language as system makes use of the Schema mechanism as the basic control device of the oscillation of its constitutive A- and O-components. Constraining and breaking of constraints portray the structural co-ordination of the A's and O's and prescribe the process of assembling the objectives into clusters. Thus grouping takes its departure in the strict dependency between agents and objectives. In discourse, the text producer continually contributes with new agent and objective couplings whose orientation is toward an increasing configurational order and the emergence of novelties.

Thus the verbal flow contains diffused objectives. But the process of formulating and re-formulating oneself constrains the diffusion over the flow by patterning the flow itself. Assembling these patterns define the quality in the path taken by the text producer. Its phase sequences and assemblies of phase sequences are from a formal logical point of view the topologically defined informational invariants manifested in the points where a bifurcation arises or where two relations cross. Every time a bifurcation can be observed, it initiates a **naming** process that makes explicit some more or less significant shifts in the orientation of the path.

It can be said that continuous changes in the independent parameters directed by intention and orientation evoke the various significant groupings of the patterns of strings of grapheme representing the terminal states of the system. This grouping is different from conventional classification of relations by means of their attributes. In the agglomeration it can be observed as a striking fact that diverse and hybrid strings of graphemes can be grouped into homogeneous clusters. When functionally similar patterns are agglomerated on the basis of intrinsic and irreversible processes, groupings become established, whose significance is conceptually indistinguishable from their constraining effects. If these effects are small, they will produce a homorhesic path. Though any time the transition from one constraining attractor state to another produces a sudden unexpected or exceptional jump, a new state attractor and thus a new path comes into existence, resulting in a hysteresis. Naming the state attractors responsible for this jump implies mediating invariants, that in a theoretical sense, are fundamentally different in their characterisation of information compared to the informational invariants characterising the path before the observed hysteresis.

Naming a cluster solution results in naming the hierarchical organisation of bifurcated point and state attractors of an evolving path. The conditional assumption is that if a configuration can be observed and named, then this implies that a structure exists. This **structure** becomes meaningfully represented first through an approach that approximates a relationship among various parts of a text as a **unity** in a plan. Thus textual transformation may be envisioned as and symbolised by a **snake** trying to bite its tail. By maintaining and manifesting topographic coherence between the names of point and state attractors the nature of the transformed information stored in the snake's path can be visualised as changes that reflect the snake's progress as controlled by topological constraints. The unity in the evolving temporal morphologies thus become **self-indicative**. Whether and to what extent perspective information can be picked up by PTA depends on how the latency of the perspective has manifested itself through linguistic cues lying in the texture of a particular text.

Aspects of Competence

The Impact of Perspectivation on Thinking in Consequences

The central idea of including the study of intentions and their possible consequences is that it represents a base line to the study of competence. What is required is a research methodology which helps making explicit to what extent a person can exert perspective control over others. For example, when parents or any other persons exert perspective control over an infant's intentions and possible movements this would imply that they overview or perspectivate the infant's development. This implies that possible movements are the object of experience, before these actually materialise within a particular environment with forthcoming effects. This means a co-operation between a person's experience of a physical and social milieu and the cognitive integration the care taker is able to achieve. Insofar as the meaning of infant-environment interaction is conceived, it is the product of the mind's synthetic activity which determines the security radius of the child.

But independent of degree of cognitive integration of environmental aspects, it has to be formulated into natural language expressions, if it shall be knowable both for the person himself and accessible for a study of competence. Transforming synthetic activity into symbolic expression entwines the perspective and viewpoints in the same way as infant and its environment are entwined. But the analysis of symbolic expression could not be performed before the perspective could be detached experimentally from its viewpoints. One prerequisite for the study of perspectivation is the search for or construction of a test material. This has to contain physical or social features that an experimental subject can perceive either on the basis of the ongoing process of making experience or on the basis of already made experiences. Therefore the material has to give expression to something that is situational and thus contextually defined otherwise neither a standpoint can be taken nor a perspective emerge. Moreover, the test material has to contain an event of a certain kind. This means that the event has to excite the values of the experimental subjects which are assumed to be deeply embedded in his mental structure. Such a material exists in a series of four pictures of the Visual Cliff published by Gibson and Walk (1960).

The well-known Visual-Cliff experiments may serve as an illustration of this point of view. These experiments could show that the majority of New-born infants of various species react adequately to a brink where the environment becomes dangerous. Based on this experimental fact, the inference drawn is, that this ability is genetically rooted in both animal and humans. Moreover, it is supposed that this phenomenon depends on a genetically rooted mechanism, called schema. The schema as biologically endowed, is implicit and the individual is not conscious of it, but its existence can be studied through its functioning. For this reason it is presumed that an approach to every-day problems this way may help close the gap between acquired knowledge which is always a priori and individual competence as something that

emerges a posteriori. Thus competence can be made explicit only in the human response to environmental change. But through language only.

The mlieu as pictured by this series constitutes a co-operation between physical and cognitive conditions. The experimental subject as observer of the child's movements has to know what it is that attracts the attention of the child, what significance the event has and what kind of actions it can elicit in the child. In the observation of the child the experimental subject can take two stand points. Either his expressions are formulated with the child's perspective and describe his observations as "my" movements, sense impressions and thinking in an unknown milieu. This perspective is narrow minded. If instead the experimental subject takes the alternative stand point, a wider perspective can emerge. This perspective builds on experience from one's own childhood and should show to what degree the person is able of conceiving an intention, i.e. to discriminate general actions from actions of a certain kind. The latter are perspectivated on the basis of the significance they have in relation to the milieu.

A summary of the results is given in Table 1. The studies show that these two stand points are taken by the experimental subjects who are parents of children of crawling age.

Table 1.

Mental Constraints of Thinking in Consequences

Orientation	Final Singularity	
	Figure	Ground
Caption to Picture Series	Falling-off Place	Avoidance
Aesthetic-Moral	Ambiguity	-
Social	Protection	-
Care	Adventure	Trust
Practical	Purposive Behaviour	Separation
Physical-Technical	Distress	Responsiveness

Those whose perception is characterised by a narrow perspective, show a tendency to describe ongoing processes of making experience. The information picked up by these persons indicates a low level of integration. Taking a narrow stand point may therefore be conceived of as the locking of perspective to the concrete. An example represented in Table 1 is the experimental subject with an "Aesthetic-Moral" interest. The phenomenon is not perceived as "depth" or "dangerousness" but something "ambiguous" or "strange". Perspectivation implies the ability to give verbal expression to thinking in consequences. Of particular importance for carrying through this process is the assumption that empirical observations are linguistically packed in such a way that ecologically valid information can be discovered. By this is meant the particular affordance that the objects of experience have at the moment of perception.

It is assumed that a picture can function as link in the study of disintegration of experience from childhood at the cognitive level or between awareness of a phenomenon and its possible knowability. The ability of cognitive disintegration should not be mixed up with parents' emotional ability or involvement. The picture series from the Visual Cliff experiments has been described verbally by parents of infants of crawling age. Their free and unrestricted verbal descriptions have been made the basis of a study of the importance of direct perception in child care (Bierschenk & Bierschenk, 1993).

From Table 1 it is obvious that "Orientation" covaries with the final outcome or singularity that emerges on a path. This path describes the competence of a parent in the form of a non-holonomic constraint whose contours are built up on the path. Similar to the infant who reacts spontaneously over the virtual cliff without being conscious of its ability, the parents as text producers are non-conscious of the mental constraints that limit their possibility to adapt

properly to the situational meaning. By applying PTA in the extraction of the topological invariants described by the termini of Table 1, it was possible to give concise topographic descriptions of manifested competence. These conceptual relations raise the question of the fundamental ability in the individual person to develop survival competence. The first and foremost task is therefore to provide the methodological framework for a study of the development of consciousness of one's possibility of making a living.

Projections of the Future

Periodically newspapers, books and scientific journals publish reflections on "globally dangerous developments". In this respect, Sperry (1993, p. 883) advances the idea that a pending catastrophe has been initiated by the "vicious spiral of mounting population". People who are currently studying the population patterns and associated xenophobic behaviour among people and groups of people believe that this kind of problems cannot be solved by merely applying more or better scientific knowledge and technology. Those who have been exposed to formal teaching may even be justifiably sceptical of the efforts made by educators to regulate their ways of thinking.

In times of economic decline and rising population, energy demands and overall environmental degradation, problems of economic and cultural disintegration become prompted and reinforce people in being aggressive as well as to challenge the value frame of authority. Families, schools and even political parties simply cannot provide the necessary "tools of thought", because their general strategies of action are defined by an entirely hierarchic thinking. This kind of thinking may help in making desirable short term changes which by definition always are of a quantitative nature. Thereby peoples' adaptation to environmental changes is organisationally managed. Moreover, this kind of monitoring may even be destructive in the otherwise valuable process of successful competition and adaptation required by new developments such as information technology, solar energy or gene manipulation. But hierarchisation of facts cannot provide the crucial methodology that may help discover the necessary qualitative changes that must be brought about if this "vicious cycle" shall be broken. Some the results are summarised in Table 2.

Table 2.

Determinants of Thinking in Global Consequences

Perceiver	Figure	Ground	Means	Goal
Business Adm.	Persistence	Valuation	-	-
Management	Ego-Strength	Advantage	Indignation	Valuation of Life
Civil Eng.	Perspective Shift	Evasion	-	-

Table 2 gives some of the results of a series of experiments which were carried out in order to simulate possible catastrophes associated with the development of technological societies. One goal was to study "mental" and "ecological" pollution as an effect of the exploitation of human and physical resources. Given a physical and social environment that is defined on the basis of technological reasoning alone, the emergent singularities have produced marked differences in the conception of making a living. With reference to simulated consequences of population growth passing important limits, a developmental progression can be observed.

The progress shows that the doctoral students of Civil Engineering are to a higher degree conscious of the cybernetic principles of the simulated model of a modern city compared to doctoral students of Business Administration and professionals, i. e. managers. It

emerges a confidence in one's capacity of scientific expertise to control overpowering by expansion in society. Fascinated by, or possibly immune to the risks taken by fostering continuous growth, its dangerous consequences have been conceived as immaterial. The doctoral students of Business Administration manifest an adjustment toward a world where moral rights count little. These students have obviously attended to the erodation of ethical principles but nevertheless concentrate on the importance of hierarchies in organisation and their repressive consequences. In comparison, professionals have perceived the contrasting sides of rationality and relational value, but do not derive a reasonable degree of consciousness. The typically conceive of themselves as autonomous individuals that are forced to examine and adjust their value system (priorities). They stand out as potent self-realisers. At one time "many years of experience" was identified with "competence", because there was a consensus among those within a discipline. But preparing students for a future that in significant ways may be different from the present industrial society requires an assessment of peoples knowing.

Interpretation of the Past

Against the background of simulated events happening in a possible future society, it may be instructive to contrast the information picked up from events that have evolved in the past society of the Suiones as described in Tacitus (Chap. 44, Germania). Table 3 gives an account of the roots of these configurations.

Table 3.

Mental Invariants of European Thinking

Translation	Figure	Ground
English	Safety	Barrier
Latin	Superiority	Dynamic Regime
French	Watchfulness	-
Italian	Dominance	Fitness
Danish	Control of Dangerousness	Adjustment
Swedish	Harnessing of Action	Safety
German	Strength	Rigorousness

Experts on Tacitus of German, English, French, Italian, Swedish and Danish origin have translated its meaning into modern descriptions. The aim of these analyses has been to provide a synthesis by means of the kind of structural wholes, manifesting itself in the structural relations of their topological configurations. The names given to the roots of the structures describe great variations in the mental determinants despite translations that are very similar content wise. The extreme cases are represented by the German focus on Strength and the English focus on Safety. The experiment makes explicit two main groupings. The English and Romance mentalities contrast with a German. The determinants of these two groups seem to divide Europe according to "a mental limes" with profound consequences for the development of competence.

Information Sensitivity at the Production Floor

An indication of the kind of constraints that can be expected will be provided with reference to an international study of mechanics. In this study PTA was used with the purpose of investigating the kind of competence Swedish, English, West-German, Italian and American Volvo mechanics would exhibit when confronted with information processing tasks. Within a

company or organisation it is of decisive import that information management is efficient, otherwise both production and budgetary activities become inhibited. To what extent disseminated information is used in every-day activities at a work-place and to what degree its distribution effects the single worker in carrying out his duties is less known. Nevertheless a company's survival potential seems in a fundamental sense depend on efficient information management. The likely kind of mental constraints operating in the determination of information processing of car-mechanics is shown in Table 4.

Table 4.

Mental Constraints Acting on Information Processing of Mechanics

Nationality	Figure	Ground
Swedish	Lack of Quality	Working Climate
English	Information Quality	Coherence
West-German	Knowledge Maintenance	Measure
Italian	Enablement	Information Structuring
US	Worthiness	Comprehension

What becomes obvious by an inspection of Table 4 is that information management cannot be considered independent of who is the anticipated receiver. Sensitivity to distributed information varies greatly. Market sensitive mechanisms seem to govern the way in which workers in different countries respond. The more market oriented the offered service is, the higher is the workers sensitivity and concentration on competence development. The roots of the mental structure of the German and US mechanics respectively give expression to outstanding competence compared to the others and especially to the Swedish workers. Their indifference to the questions answered marks them as border-line cases. Thus, advanced production methods and associated technical developments of service support units administering information management cannot speed up information pick-up of the workers. On the contrary, computer-based service development contributes only to more pronounced steering of the information flow and more administrative tasks. What is lacking, according to the English mechanics, is an adequate conceptual development that can be comprehended as coherent whole with respect to the service problems to be solved. Moreover, what is asked for by the Italian mechanics are functions that enable one's conceptual orientation, structuring and transformation toward the development of needed competence.

Policy Formation Processes

Knowledge of existing mental structures and how these influence subsequent professional success would greatly enhance a company's survival potential. How mental structures effect the individual in a competitive (survival) situation is a further condition of crucial import for an understanding of processes through which competence develops. The idea that one's successfulness is dependent on one's competitiveness is especially favoured among business men. Closely related to the success-competition interaction is a kind of policy developed, implying that a company can initiate its re-orientation only by means of firing and hiring. For demonstrative purposes a Power Production Company's way of responding to policy problems posed by the energy crises during the 1970s and emergent consciousness of environmental pollution of the 1980s will be summarised in Table 5.

Table 5.

Mental Determinants of Policy Formation Processes

Annual Report	Figure	Ground	Means	Goal
1979	Consensus	Adaptation	Calculation	Binding
1981	Consciousness	Operation-alisation	Difference	Synergy
1983	Functional Synergy	Reliability	Objectivation	Constructivity

The changing conditions of surviving on the market make a difference for both the company and its Managing Director. As shown in Table 5, the roots of the mental structure underlying the Annual Report of 1979 give expression to an enterprise that is highly dependent on resource management. This kind of steering characterises the Power Plant as a company that is dependent on government and municipality bodies. Information management is in this kind of directing activities concentrated on one-way communication and the imposition of obligations. Traditional studies in Economics and Business Administration are designed to provide for the development of cognitive skills as represented by the Managing Director responsible for the Annual Report of 1979.

It builds on the assumption that consumer behaviour can be "calculated". Moreover, its "consensus" orientation marks this kind of higher education as being founded on the classical rational model of economics. The idea behind this model is that an individual as well as a company "adapts" with perfect foresight to economic incentives and deterrents. In agreement with the model of rational decision making, "office automation" reinforces the utilitarian's concentration on the development of administrative power and his concern with distributive justice when delivering the quantities people have chosen to consume. Compulsory distribution of energy is the necessary precondition for the individual's possession of freedom of choice. Consequently, the choices people make are protected by the law. Only insofar as an individual has an opportunity to decide differently on his level of consumption is there a freedom of choice. Protected choice is associated with a special warrantee and "Binding" to the company's administration. Organisational policy formulated in terms of effectiveness and distributional justice, however, will not contribute to the resolution of problems associated with environmental crises. Changing the organisation means exchanging the individual. The "Consensus" orientation represented by the Managing Director of the 1979 Annual Report appeared to be a barrier to the adoption of more energy efficient technologies and practices related to the alleviating consumer factor. Thus, success in the administration's activities and their modification can be traced to competence development. The underlying assumption is that success in organisational activities and their modification is highly dependent on the competence represented by certain individuals in the organisation.

In 1980 it was decided to suspend the administrative orientation and to make management less dependent on administrative data bases. Instead, management was expected to favour work that required unique solutions to up-coming problems. By hiring a new Director a profound re-orientation was initiated. The roots of the mental structures of the Annual Report of 1981 clearly signal the import of a confidence in information processing as opposed to data processing. As a result a new singularity emerged which was named "Consciousness". This term introduces a moral component into the policy formation process. With "Consciousness" as final outcome of the Figure-component, "morality is given priority over science" as Sperry advocates in 1983. The reason emphasised concentrates on the realisation of an "Operationalisation" by means of an experimental conduct. Observed "Differences" define the effectiveness of initiated system changes. The efficiency in information

pick-up, conceptualisation, and formulating its significance into policy statements defines successfulness. The policy of this Director must effortfully control technological choices in order to ensure a "Synergy" effect. Thus, the higher the financial investment, the more essential become the mental determinants. Improving the implementation of energy efficient technologies is highly dependent on the Director's mental structure. At the horizon of this Director "Synergy" emerges as a most important Goal.

Progress in understanding the effect of mental constraints on competence and the materialisation of conceptual steering mechanisms requires a developmental approach to information management. In the present context it is based on the Annual Report of 1983. Analysing this document may be viewed of as a follow-up of changes anticipated in 1981. The major change is associated with the term "Functional Synergy", which now appears as the proximate outcome of the Figure-component. The essential foundation for this outcome is expressed through the Ground-component, whose singularity concerns the "Reliability" of the organisation. The Means-component marks "Objectivation" as the line of conduct. It refers here to an organiser, who plans, devices and frames the projects (i.e. objectives) to be carried out. Finally, the Goal-component represents the planner's "Constructivity" as distal effect. It addresses his concern with the establishment of a relationship between several projects. This is a distal situation, where the process is not presently observable but is assumed to exist, because it (hypothetically) gives rise to the generation of measurable phenomena.

Clearly the two Managing Directors illustrate what kind of mental constraints are operating in policy formation processes. The competence of the first is limited by an in itself well developed analytical ability and environmental adaptation by means of an utility function. The major mental determinant of this is "Consensus" which constrains his choice of action to a body of value as represented by some authority.

His successor establishes an organisation that is the product of the second law of thermodynamics. Over and above his analytical skills, he demonstrates his competence by means of synthesis. Independent of the task orientation, this is expressed through his ability of expressing the company's policy in verbal and written form. Moreover, qualified consulting work and task force reports are taken as relevant expressions of concept formulation ability. Because information pick-up concerns thought processes but not production of statistics or any other economic reports, its expression is dependent on the inherent dynamics of language. A coherent time-independent structure (the organisation) emerges, which owes its origin and characteristic features in large part to experimentation and measurement of the dissipative processes that the policy processes engender. His competence gets expression in the formulation of the "Operationalisation" of strategy and the observation of "Distances". These can be witnessed by others. Hence, his reality rests on "knowing-together", i. e. consciousness or competence. This outcome presupposes a co-ordinative conduct on behalf of this manager which stands in contrast with his predecessor's sub-ordinative orientation. Only a realisation of system co-ordination can generate macroscopic structures as a result of his actions, and thus at the horizon appears "Synergy" as the valued Goal of his co-ordinative conduct.

In 1983, this goal is achieved, because "Synergy" has been transformed into "Functional Synergy". This is now the conceptual limit of the Figure-component. This mental constraint addresses linkages and bifurcations. On the basis of subtle and mutually dependent relationships between the informational aspects of sub-systems, in a constructive way, a diversification of a large scale power plant has been achieved. Its common ground is a monitoring of natural uncertainty (fluctuations) in decision making through concentration on the reliability in the behaviour of its ensembles. In this view, fluctuations in the process are controlled by grouping the units into larger ensembles. The ensembles are functional groups that can be controlled by utilising the synergy principle, i. e. by concentrating competence.

Discussion

The distinction between competence and performance is usually made with reference to language. In the study of language and psycholinguistics the embodiment of "abstract rules" deeply embedded in cognitive structure are distinguished from what can be observed and measured outcome. Thus, the effectiveness in one's use of a language is different from the processes which generate a language. The single and most important deficiency are the models of linguistic knowledge, language acquisition and behaviour. Their failure is to be found in the designed procedures and proposed theories of universal grammar. This excludes the study of language as natural phenomenon on its own premises.

The competence-performance distinction has been out of discussion for a long time, mainly due to the fact that competence could not be excluded from performance. So far no one has been able to find a way out of the interdependence, because any meaningful verbal response to psychological tests of proficiency combines them. This kind of tests is an integrated component in the measure of IQ. A long research tradition has tried to establish its heredity as well as co-variation with cultural patterns, child rearing practices, educational experiences and personality measures. To what extent this research has produced interesting results depends on one's scientific perspective. At present psychological theory by no means has produced any acceptable explanation of the fact that two individuals, possessing comparable language skills and professional knowledge, **functionally** differ as significantly as e. g. the two managing directors involved in policy formation processes concerning energy production.

Moreover, there is convergent evidence that the individual may demonstrate outstanding achievements despite lack of peak performances on classical tests. Currently, educational and psychological research is unable to produce a satisfactory explanation of exceptional achievement patterns. The reason is that the production aspect incorporates evolution, that is irreversible time, and this circumstance cannot be handled by traditional knowledge models. But continued developmental growth ultimately depends on the perspectivation of the knowledge base of a discipline. With PTA the individual's perspectivation of knowledge can be made explicit which means that PTA provides a resolution to the problem of explaining exceptional achievement.

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